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# Antiproton Acceptance Technical Aspects

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Temple Review  
July 1, 2003

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# Scope

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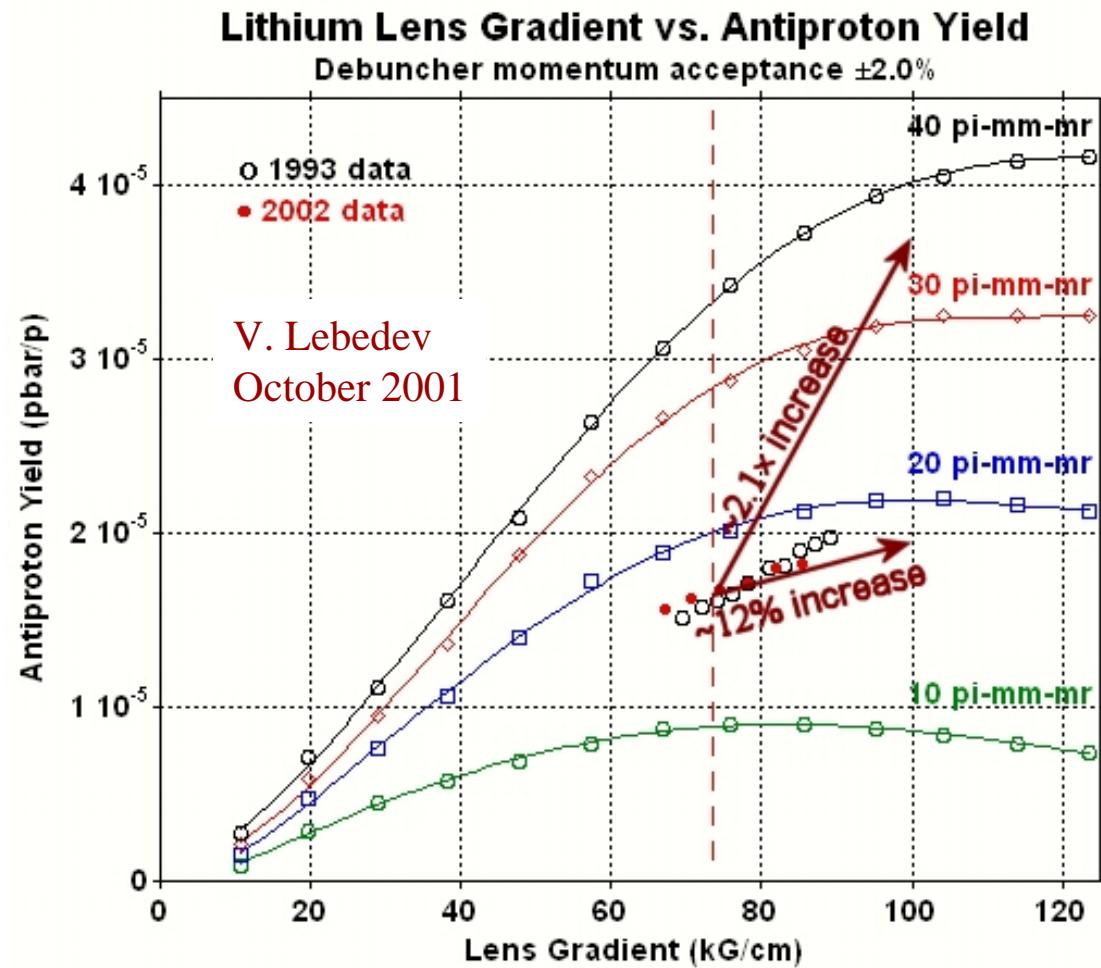
## Two Projects:

1. High Gradient Lithium Lens Upgrades  
Project Leader: Jim Morgan
  
2. AP2 Beamline and Debuncher Acceptance  
Improvements  
Project Leader: Keith Gollwitzer

# Motivation

Increase the number of antiprotons collected from the target by:

- increasing the gradient of the collection lens
- increasing the admittance of the AP2 beamline and the Debuncher



# High Gradient Li Lens - Present Performance

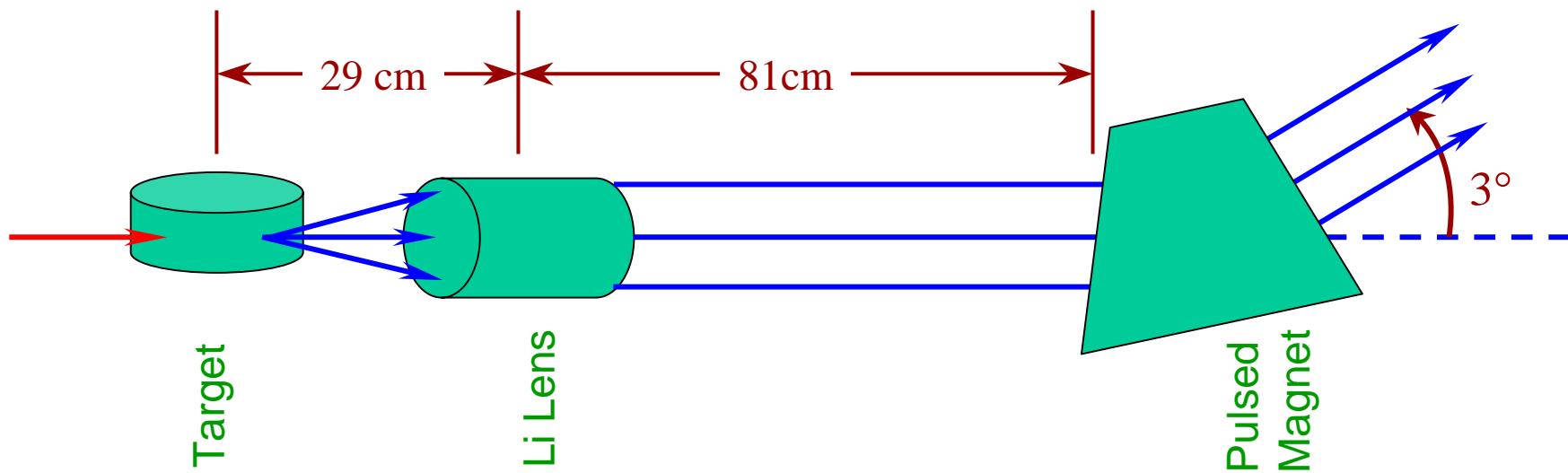
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Gradient (T/m)	Average Number of Pulses to Failure
1000	<500,000
900	1,000,000
800	3,500,000
745	9,000,000
700	>10,000,000

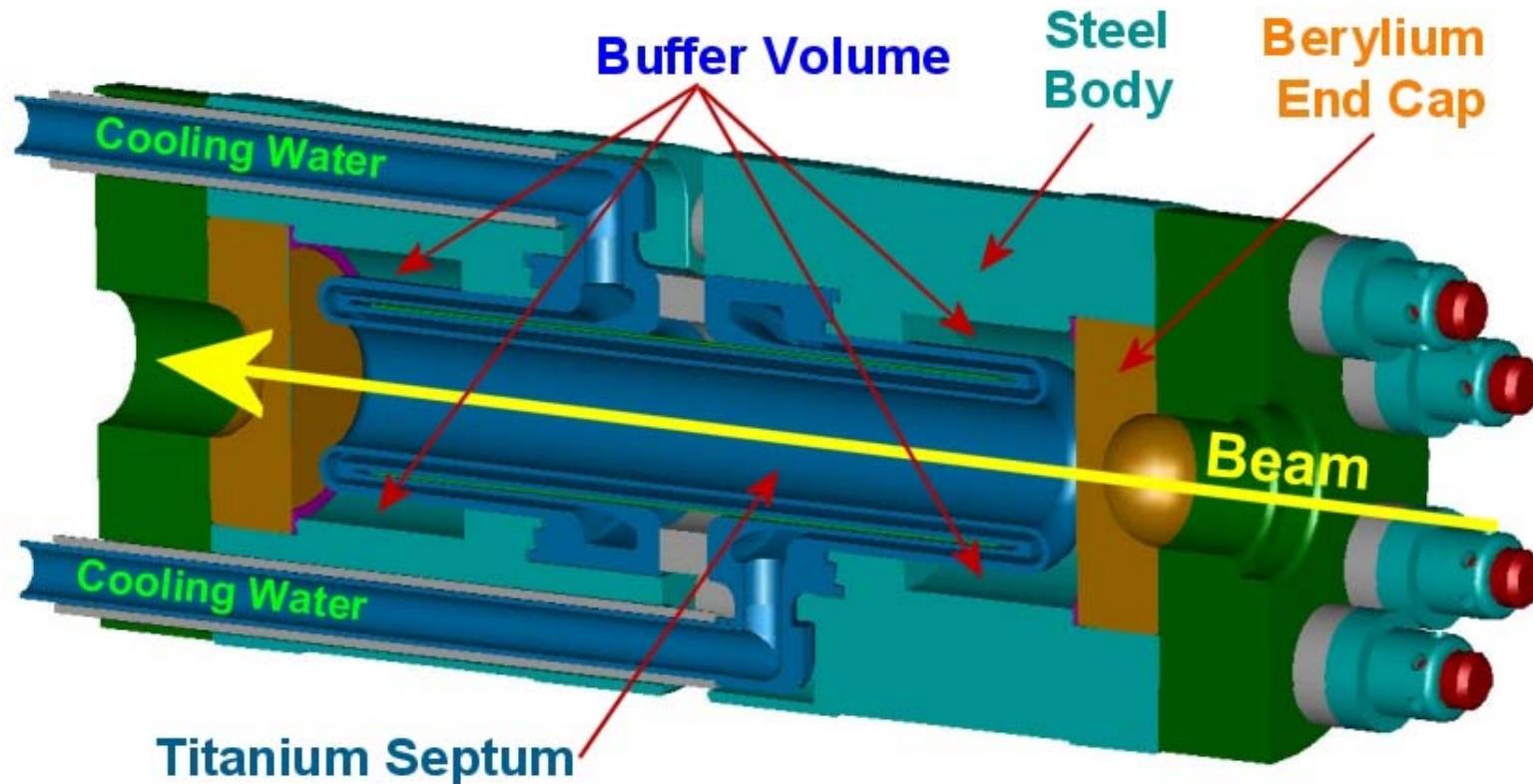
- *Operation at gradients greater than 745 T/m significantly degrades the lifetime of the lens*
  - *The two most recent lenses survived over 9 million pulses*
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# High Gradient Li Lens -- Parameters

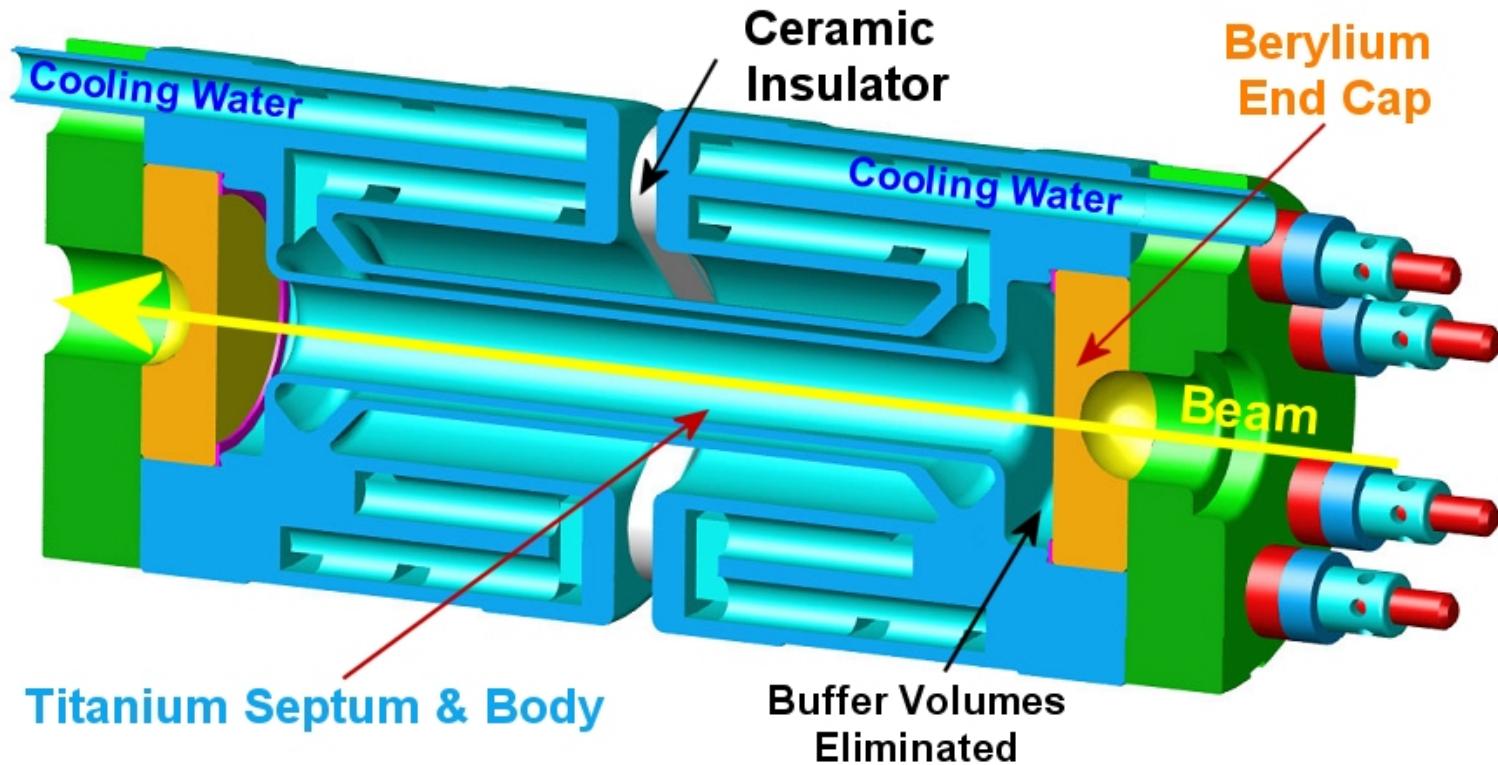
	Present	Upgrade
Gradient	745 T/m	1000 T/m
Radius	1.0 cm	1.0 cm
Length	15 cm	15 cm
Lifetime	$\sim 9 \times 10^6$ pulses	$10 \times 10^6$ pulses



# High Gradient Li Lens - Present Design



# High Gradient Li Lens - New Design

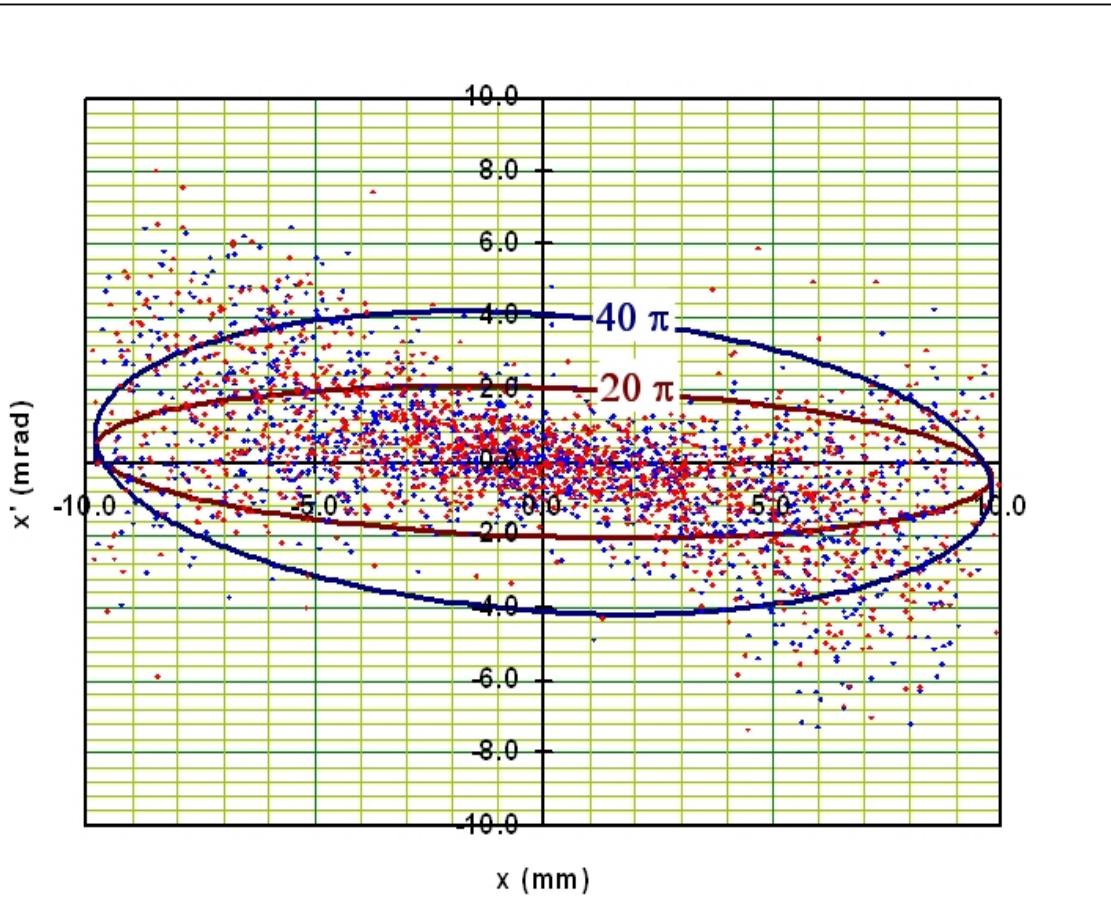


## Features:

- Diffusion bonded titanium body
- Thicker septum
- Li buffer volumes eliminated

*Prototype #1 is  
ready to be filled*

# AP2 & Debuncher Acceptance -- Motivation



$\bar{p}$  phase space distribution exiting the lens for a lens gradient of 750 T/m.

$$\Delta p/p < 2.25\%$$

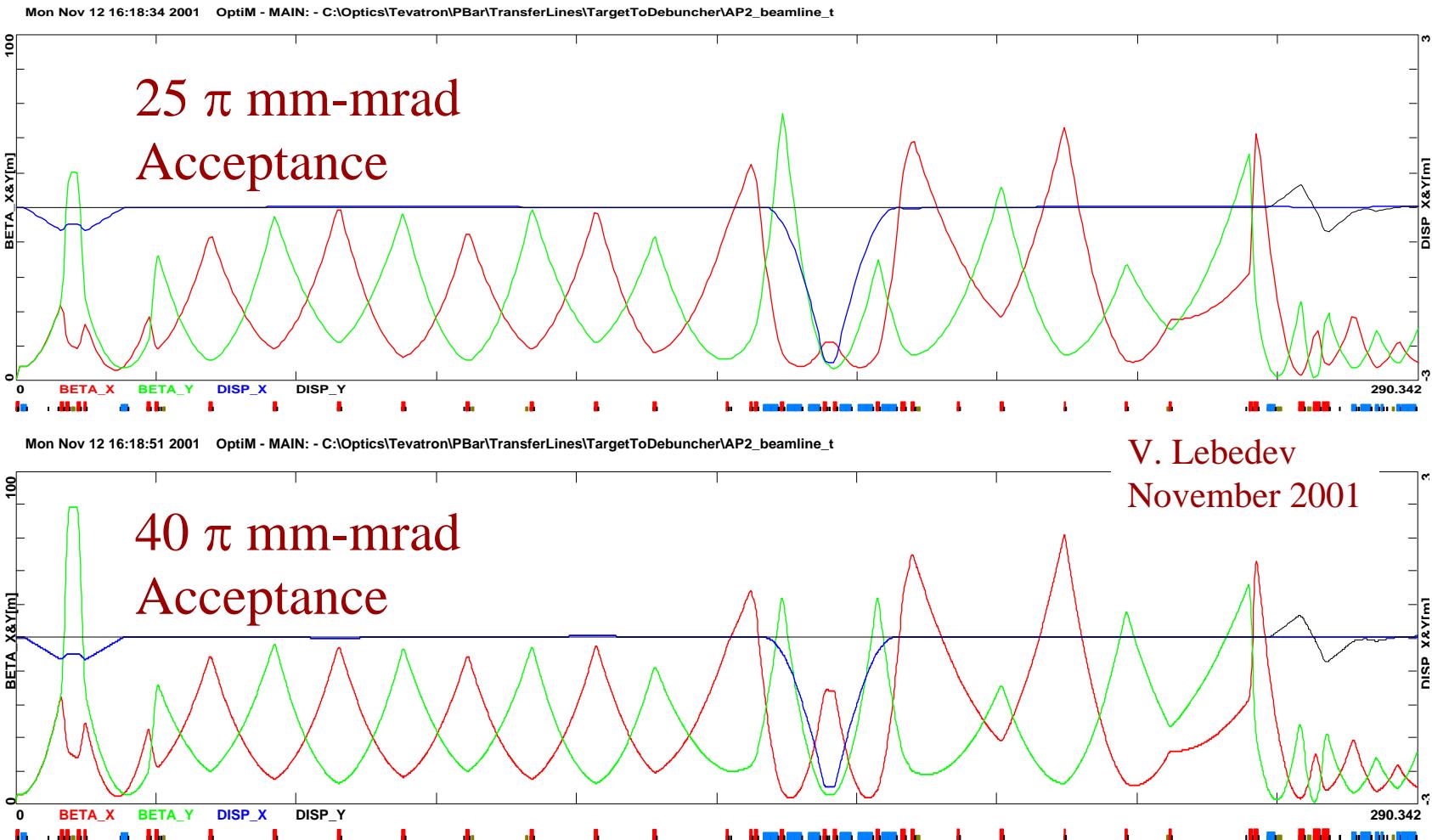
Blue dots are horizontal,  
Red dots are vertical  
(i.e. 2 points per  $\bar{p}$ )

Note: the  $20 \pi$  and  $40 \pi$  ellipses represent two different AP2 lattices. The AP2 optics has been adjusted to match Li lens aperture.

$$\beta_{lens} = \pi \frac{r_{lens}^2}{A_{AP2}}$$

**Goal:**  $35 \pi$  mm-mrad transverse admittance

# AP2 & Debuncher Acceptance - AP2 Lattice

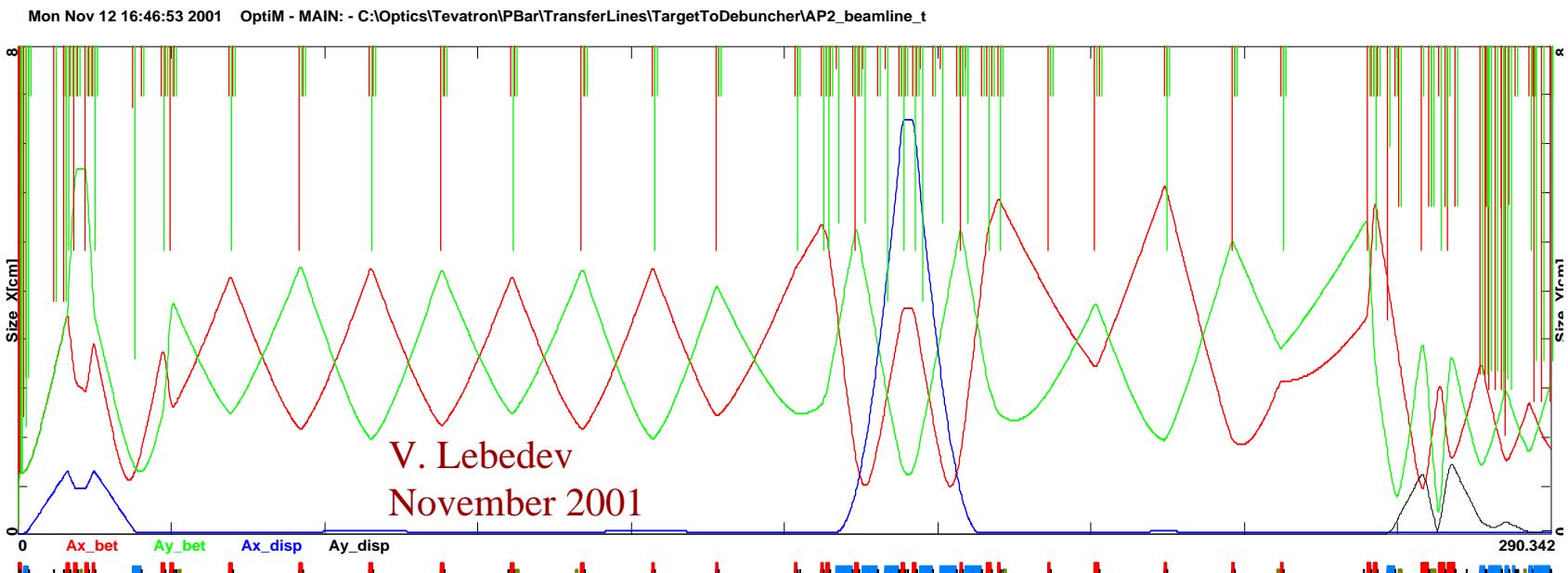


# AP2 & Debuncher Acceptance -- Parameters

	Recent Measurements	Physical Aperture	Goal
Horizontal (mm-mrad)	$20 \pm 1.5 \pi$	$40 \pi^{\dagger}$	$35 \pi$
Vertical (mm-mrad)	$12 \pm 1.5 \pi$	$40 \pi^{\dagger}$	$35 \pi$
Momentum	$\pm 2.25\%$	$\pm 2.25\%$	$\pm 2.25\%$

<sup>†</sup> There are several locations where the physical aperture is known to be less than the admittance indicated in this table (e.g. Band 4 cooling pickups and kickers, Debuncher quadrupole D4Q4, DRF2 and DRF3 cavities).

# AP2 & Debuncher Acceptance - AP2 Aperture



Beam envelopes in AP2 line for an admittance of  $40 \pi \text{ mm-mrad}$ .  
Aperture limitations are shown by the vertical lines extending from the top of the plot. Synchrotron size is shown for an energy spread of 2.5%.

The aperture information in this plot is incomplete and somewhat out of date. Updated information is being developed by the Tech. Div. Documentation and drawing survey.

# AP2 & Debuncher Acceptance - Beam Studies

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## Reverse Proton Studies

- Commission upgraded BPMs
- Measure Debuncher lattice
- Commission orbit correction with motorized quad stands
- Center  $\Delta p/p = 0$  beam in the quads
- Identify limiting apertures using loss monitors

## Stacking Studies

- Measure combined AP2 + Debuncher acceptance
- Use SEMS to center AP2 beam in quads

## Forward Proton Studies

- AP2 Lattice measurements
- Center beam in quads